

Working with Reference Materials in Nucleonica

Zs. Soti

Uranium Isotopic Reference Material SRM 071

- Nuclide Mixtures – Create the SRM mixture
- Decay Engine – Nuclide composition today (or any other date)
- Decay Engine – Activity at creation time and today or any other date
- Dosimetry & Shielding – dose rate, gamma lines at creation time and today
- GSG – Gamma spectra at creation time and today
- Cambio File Converter to compare

Uranium Isotopic Reference Material SRM 071

- On 1. July 1977 200 g of natural uranium sample chemically separated and has been prepared as SRM 071
- Create the SRM 071 mixture in Nucleonica
- Show the nuclide composition today
- Compute the activity at the creation time and today.

Nucleonica - Nuclide mixtures - Windows Internet Explorer


http://www.nucleonica.com/Application/NuclideMixtures.aspx

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Nucleonica - Nuclide mixtures

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Nuclide Mixtures

[Getting started](#)
[Reference manual](#)

My Mixtures Edit Upload **Sample Mixtures**

Select	Sample Mixture Name	Date Modified	Delete
<input type="checkbox"/>	Ce-144 / Pr-144	02.04.2012, 14:06:35	
<input type="checkbox"/>	Cs137 / Ba137m	02.04.2012, 14:07:29	
<input type="checkbox"/>	Fuel element with enriched uranium and ZrH1.6. Total mass is 100 g.	26.06.2012, 13:58:55	
<input type="checkbox"/>	Fukushima spectrum	22.05.2012, 16:35:01	
<input type="checkbox"/>	HEU, highly enriched uranium	06.05.2011, 13:32:54	
<input type="checkbox"/>	I131_Cs137_mixture	14.03.2011, 16:22:45	
<input type="checkbox"/>	Natural Thorium	10.03.2010, 13:36:26	
<input type="checkbox"/>	Natural Uranium	08.04.2010, 15:50:06	
<input type="checkbox"/>	Rb-81/Kr-81m Generator	06.01.2011, 17:03:59	
<input type="checkbox"/>	Reactor Grade Pu Sample	10.05.2011, 13:33:12	
<input type="checkbox"/>	Sr-90 / Y-90	29.03.2012, 14:51:09	
<input checked="" type="checkbox"/>	SRM 071 U isotopes separated 1. July 1977	28.06.2012, 15:19:14	
<input type="checkbox"/>	Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18	
<input type="checkbox"/>	U232+Co60	10.03.2010, 13:50:08	

Send to My Mixtures

Nucleonica - Nuclide mixtures - Windows Internet Explorer


http://www.nucleonica.com/Application/NuclideMixtures.aspx

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 **Nuclide Mixtures** [Getting started](#) [Reference manual](#)

My Mixtures **Edit** Upload Sample Mixtures

Name
SRM 071 U isotopes separated 1. July 1977

Description:
200 g natural uranium (U234, U235, U238) with isotopes fractions corresponding to the

Significant figures: 4

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
⁹² U 234	2.443e+6	0.01062	2.732e+19	5.310e-5	5.400e-5	0.4860	
⁹² U 235	1.138e+5	1.423	3.645e+21	7.114e-3	7.204e-3	0.02264	
⁹² U 238	2.469e+6	198.6	5.023e+23	0.9928	0.9927	0.4913	
Total: 3	5.026e+6	200.0	5.060e+23	1.000	1	1	

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Nuclide composition of SRM 071 today

- Decay Engine
- Mixture Selector – SRM 071
- Activity in Bq at creation time $5.03\text{e}+6$ Bq
- Options Tab – select Date
- Decay Engine tab – date 1 July 1977,
today
- Start

Nucleonica - Decay Engine - Windows Internet Explorer

http://www.nucleonica.com/Application/FullDecay.aspx

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New Alerts

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Decay engine

SRM 071 U isotopes separated 1. July 1977

Mixture

SRM 071 U isotopes separated 1. July 1977

Nuclide selector

Decay Engine Options Decay Tree Mixture details

Starting date /time

Final date /time

Time span

01.07.1977 12:00:00

28.06.2012 13:43:17

34.9934 Years

Starting quantity

Final quantity

Unit

5.03E+06

???

Becquerel

Start

Reset

Type of graph:

Activities

Questions, remarks, suggestions can be posted in the forum

Calculation details

Number of timesteps:

40

Accuracy Factor:

5.40E-06

Distance (cm):

100

Number of linear chains:

???

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Nucleonica - Decay Engine - Windows Internet Explorer

http://www.nucleonica.com/Application/FullDecay.aspx

Starting date / time: 01.07.1977 12:00:00
Final date / time: 28.06.2012 13:43:17
Time span: 3.50E+01 Years

Starting quantity: 5.03E+06
Final quantity: 1.01E+07
Unit: Becquerel

Calculation details:
Number of timesteps: 40
Accuracy Factor: 5.40E-06
Distance (cm): 100
Number of linear chains: 10

Plot	Parent-Daughters	Half-life	N(atoms)	A(Bq)	A.alpha(Bq)	A.beta(Bq)	Ing.Radiot(Sv)	γ Dose rate(μSv/h)	Disintegrations	α par	
✓	Total:		5.06E+23	1.01E+07	5.03E+06	5.06E+06	2.45E-01	1.22E-02	5.06E+23	5.55E	
✓	92 U238	4.5E9 y	5.03E+23	1.99E+02	2.47E+06	2.47E+06	1.09E-05	1.11E-01	2.37E-05	2.73E+15	2.73E
✓	91 Pa234 m	1.17 m	2.50E+08	9.73E-14	2.47E+06	0	2.47E+06	0			
✓	90 Th234	24.09 d	7.42E+12	2.88E-09	2.47E+06	0	2.47E+06	8.40E-03			
✓	92 U234	2.5E5 y	2.73E+19	1.06E-02	2.44E+06	2.44E+06	0	1.20E-01			
✓	90 Th231	1.06 d	1.51E+10	5.79E-12	1.14E+05	4.55E-08	1.14E+05	3.87E-05			
✓	92 U235	7.0E8 y	3.65E+21	1.42E+00	1.14E+05	1.14E+05	0	5.35E-03			
□	91 Pa234	6.78 h	1.31E+08	5.07E-14	3.71E+03	0	3.71E+03	1.89E-06			
□	90 Th230	7.5E4 y	2.70E+15	1.03E-06	7.86E+02	7.86E+02	0	1.65E-04			
□	91 Pa231	3.3E4 y	1.26E+14	4.82E-08	8.43E+01	8.43E+01	0	5.98E-05			
□	89 Ac227	21.79 y	3.32E+10	1.25E-11	3.34E+01	4.62E-01	3.30E+01	3.68E-05			
□	88 Ra223	11.43 d	4.74E+07	1.75E-14	3.33E+01	3.33E+01	0	3.33E-06			
□	86 Rn219	3.96 s	1.90E+02	6.91E-20	3.33E+01	3.33E+01	0	0			
□	82 Pb211	36.1 m	1.04E+05	3.64E-17	3.33E+01	0	3.33E+01	5.99E-09			
□	83 Bi211	2.17 m	6.25E+03	2.19E-18	3.33E+01	3.32E+01	9.08E-02	0			
□	81 Tl207	4.77 m	1.37E+04	4.71E-18	3.32E+01	0	3.32E+01	0			
□	90 Th227	18.72 d	7.67E+07	2.89E-14	3.29E+01	3.29E+01	0	2.89E-07			
□	88 Ra226	1.6E3 y	4.32E+11	1.62E-10	5.93E+00	5.93E+00	1.19E-04	1.66E-06			

Nucleonica - Decay Engine - Windows Internet Explorer

http://www.nucleonica.com/Application/FullDecay.aspx#GotoGraph

Download: ☒ Excel ☐ CSV Separator: Semicolon (";") ☒ Use field qualifier ("")

Update Graph Select all Nuclides Unselect all Nuclides

☐ Show rescale tool

Type of graph: Activities

Time: 17.44 years (19)

Curve	Nuclide	Activity [Bq]	16.6	17.5
92 U234	92 U234	2.44E+6	2.44E+6	2.44E+6
92 U235	92 U235	1.14E+5	1.14E+5	1.14E+5
90 Th231	90 Th231	1.14E+5	1.14E+5	1.14E+5
92 U238	92 U238	2.47E+6	2.47E+6	2.47E+6
90 Th234	90 Th234	2.47E+6	2.47E+6	2.47E+6
91 Pa234 m	91 Pa234 m	2.47E+6	2.47E+6	2.47E+6
Total:	Total:	1.01E+7	1.01E+7	1.01E+7

Graph of 5.03E+06 Bq SRM 071 U isotopes separated 1. July 1977 during 3.50E+01 Years

SRM 071

- Compute the gamma dose rate at the creation time and today – distance 1 m
- Display gamma lines at the creation time and today
- Dosimetry and Shielding application (no shielding)

Nucleonica - Dosimetry and Shielding - Windows Internet Explorer

http://www.nucleonica.com/Application/Shielding.aspx

Mixture: SRM 071 U isotopes separated 1. July 1977 Nuclide selector

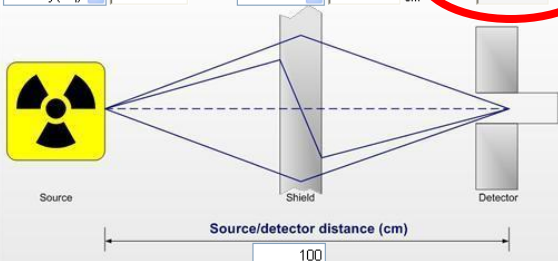
☐ Include daughters

Dosimetry and Shielding | Dose rate/Thickness graph | Options | Mixture details

Initial source strength: Activity(Bq) 5.03E+06

Shielding material: Pb 0 cm

Dose rate ($\mu\text{Sv/h}$) 2.45E-03



Source | Shield | Detector

Source/detector distance (cm) 100

Start Reset

Half-Value Shield Thickness(cm)	8.00E-02
Tenth-Value Shield Thickness(cm)	2.00E-01
Equivalent Dose Rate Constant Γ (mSv·m ² /GBq·h)	4.88E-04

Nucleonica - Dosimetry and Shielding - Windows Internet Explorer

http://www.nucleonica.com/Application/Shielding.aspx

Number of lines (γ): 58 Σ E.P.(γ): 1.49E+05

Number of lines (α): 16 Σ E.P.(α): 1.75E+04

Number of lines ($\gamma+\alpha$): 74 Σ E.P.(total): 1.66E+05

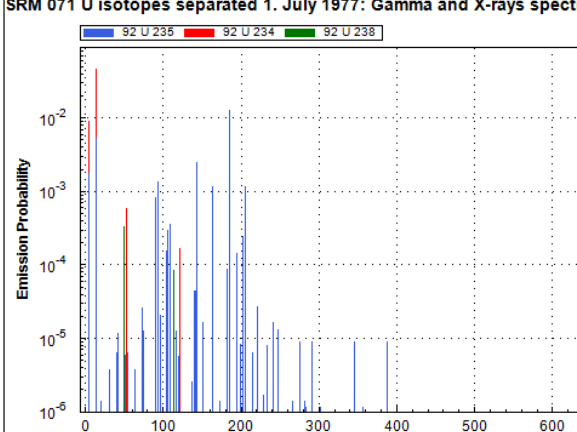
Download ☒ Excel ☐ CSV Separator: Semicolon (",") ☒ Use field qualifier ("")

Nuclide	Half-life	Activity (Bq)	Mass (g)	Tissue γ Dose Rate ($\mu\text{Sv/h}$)	γ Exposure rate ($\mu\text{Gy/h}$)
92 U 235	704 My	1.14E+05	1.42E+00	2.39E-03	2.10E-03
92 U 234	245.5 ky	2.44E+06	1.06E-02	4.37E-05	4.18E-05
92 U 238	4.468 Gy	2.47E+06	1.99E+02	2.27E-05	4.22E-05
3 Nuclides	Page: 1 / 1	5.02e+6	2.00e+2	2.46e-3	2.18e-3

Download ☒ Excel ☐ CSV Separator: Semicolon (",") ☐ Use field qualifier ("")

☐ Show radiation details

SRM 071 U isotopes separated 1. July 1977: Gamma and X-rays spectrum



92 U 235 92 U 234 92 U 238

Emission Probability

Gamma Energy (keV)

Include daughters Cooling Time 35 y

Nucleonica - Dosimetry and Shielding - Windows Internet Explorer

http://www.nucleonica.com/Application/Shielding.aspx

Mixture: SRM 071 U isotopes separated 1. July 1977

Include daughters: ☒ "Cooling" time: 35 Years

Dosimetry and Shielding | Dose rate/Thickness graph | Options | Mixture details

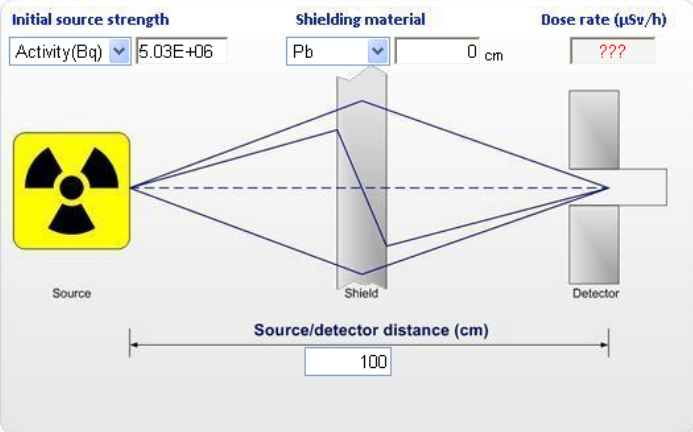
Initial source strength: Activity(Bq) 5.03E+06

Shielding material: Pb 0 cm

Dose rate ($\mu\text{Sv/h}$): ???

Source/detector distance (cm): 100

Start Reset



The diagram illustrates a radiation shielding setup. On the left is a yellow square source with a black radiation symbol. In the center is a grey rectangular shield. On the right is a grey rectangular detector. A dashed line connects the source to the detector, passing through the shield. A double-headed arrow below the shield indicates the source/detector distance is 100 cm. The shield is labeled 'Shield' and the detector is labeled 'Detector'.

☒ Include daughters

"Cooling" time

35 Years

Dosimetry and Shielding

Dose rate/Thickness graph

Options

Mixture details

Initial source strength

Activity(Bq) $5.03\text{E}+06$

Shielding material

Pb 0 cm

Dose rate ($\mu\text{Sv/h}$)

$1.20\text{E}-02$

Source

Shield

Detector

Source/detector distance (cm)

100

Start

Reset

Half-Value Shield Thickness(cm)

$2.70\text{E}-01$

Tenth-Value Shield Thickness(cm)

$3.04\text{E}+00$

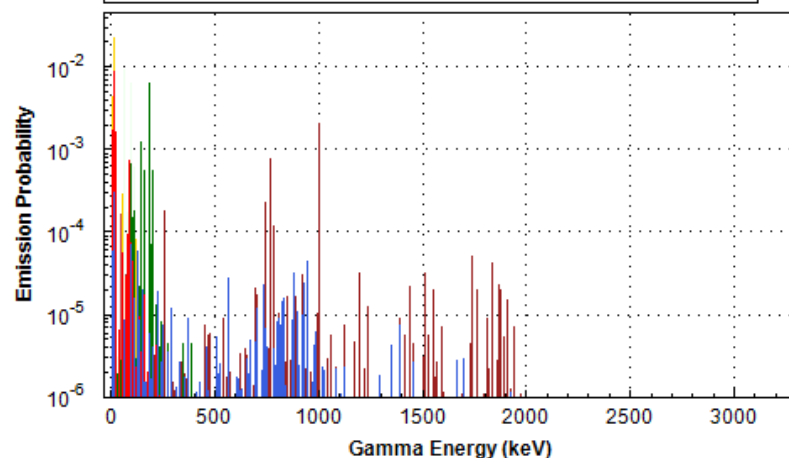
88 Ra 226	1.600 ky	5.92E+00	1.62E-10	5.58E-09	4.88E-09
87 Fr 223	22.00 m	4.61E-01	3.22E-19	4.14E-09	3.96E-09
89 Ac 227	21.772 y	3.34E+01	1.25E-11	1.21E-09	1.31E-09
28 Nuclides	Page: 1 / 2	1.01e+7	2.00e+2	1.20e-2	1.17e-2

Download Excel CSV Separator: Semicolon (",") Use field qualifier (")

Show radiation details

71 U isotopes separated 1. July 1977: Gamma and X-rays after 35 Years c

91 Pa 234	90 Th 231	92 U 235	83 Bi 214
90 Th 227	91 Pa 231	82 Pb 214	87 Fr 223
88 Ra 223	82 Pb 210	83 Bi 211	86 Rn 219
92 U 234	90 Th 234	92 U 238	90 Th 230
82 Pb 211	88 Ra 226	89 Ac 227	91 Pa 234m
81 Ti 207	86 Rn 222	84 Po 210	84 Po 218
83 Bi 210			



Show Graph Settings

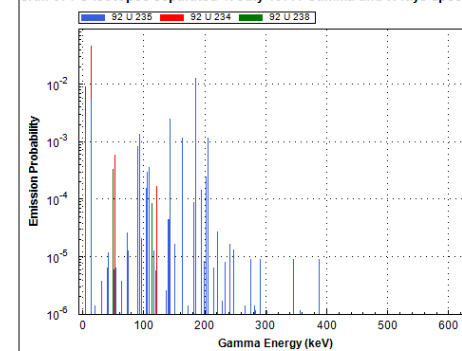
Number of lines (γ):	58	Σ E P (γ):	1.49E+05
Number of lines (X):	16	Σ E P (X):	1.75E+04
Number of lines (γ+X):	74	Σ E P (total):	1.66E+05

Download Excel CSV Separator: Semicolon (",") Use field qualifier (")

Nuclide	Half-life	Activity (Bq)	Mass (g)	Tissue γ Dose Rate (μSv/h)	γ Exposure rate (μGy/h)
92 U 235	704 My	1.14E+05	1.42E+00	2.39E-03	2.10E-03
92 U 234	245.5 ky	2.44E+06	1.06E-02	4.37E-05	4.18E-05
92 U 238	4.468 Gy	2.47E+06	1.99E+02	2.27E-05	4.22E-05
3 Nuclides	Page: 1 / 1	5.02e+6	2.00e+2	2.46e-3	2.18e-3

Download Excel CSV Separator: Semicolon (",") Use field qualifier (")

SRM 071 U isotopes separated 1. July 1977: Gamma and X-rays spectrum

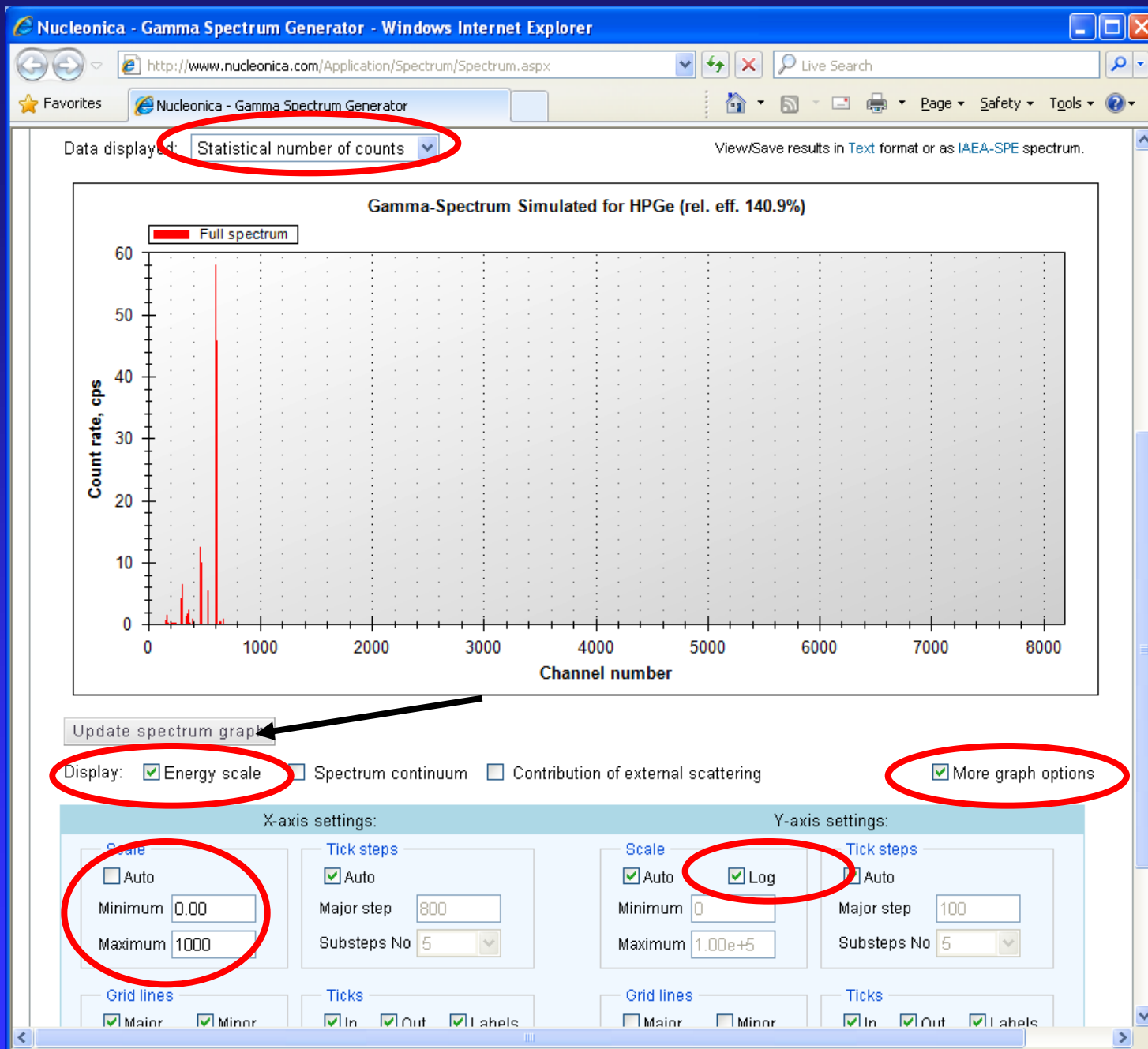


Gamma spectrum of SRM 071

- Create the gamma spectrum of SRM 071 after separation
- 35 years later
- Compare those with Cambio File Converter

Gamma Spectrum Generator without daughter products

- Start the Gamma Spectrum Generator application
- Total activity 5.026×10^6 Bq
- Detector HPGe 150 %
- Measurement time 1 h
- Start



←

→

⌵

http://www.nucleonica.com/Application/Spectrum/Spectrum.aspx

↺

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Nucleonica - Gamma Spectrum Generator

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📄

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Gamma Spectrum Generator

Natural Uranium

Actual chart: Karlsruhe

Getting started

Reference manual

Questions, remarks, suggestions
can be posted in the **forum**

Nuclide Mixtures:

Natural Uranium ▾

Nuclide Selector

Total activity:

Bequerel ▾

5.026e+6

Reference point:

Measurement start ▾

Measurement setup

Calculation results

Options

Measurement time:

sec ▾

1000

Start

Start in background

Current configuration:

HPGe, coaxial, p-type, rel. eff. 50% (default) ▾

Save as

Delete

Dimensions in

mm ▾

Source

Filter

HPGe
Crystal

59.0
Crystal diameter

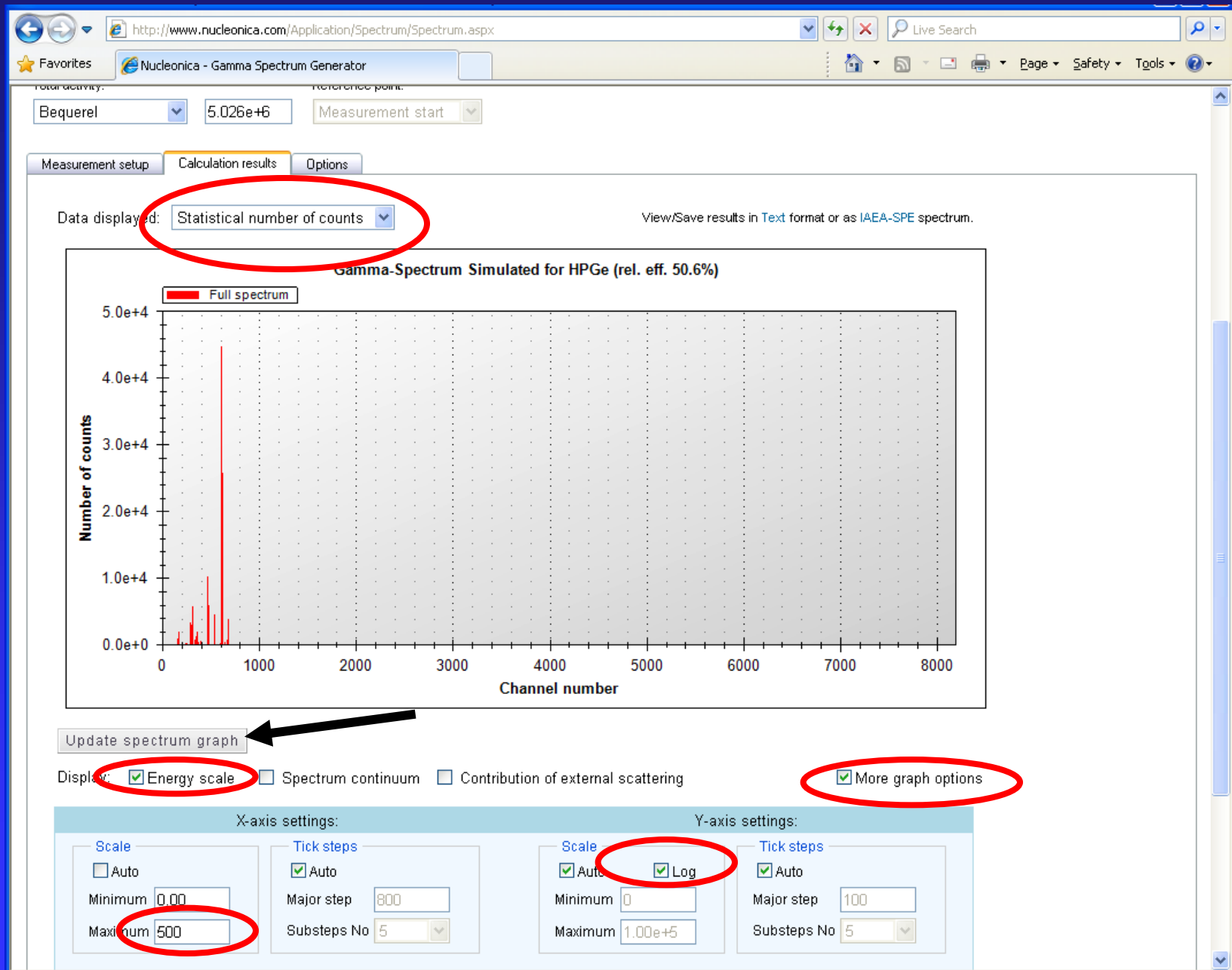
10.0
Contact diameter

45.0
Contact length

70.0
Crystal length

250.0
Source to Detector distance

☐ Show more settings

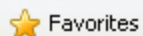




http://www.nucleonica.com/Application/Spectrum/Spectrum.aspx



Live Search



Nucleonica - Gamma Spectrum Generator



Page

Safety

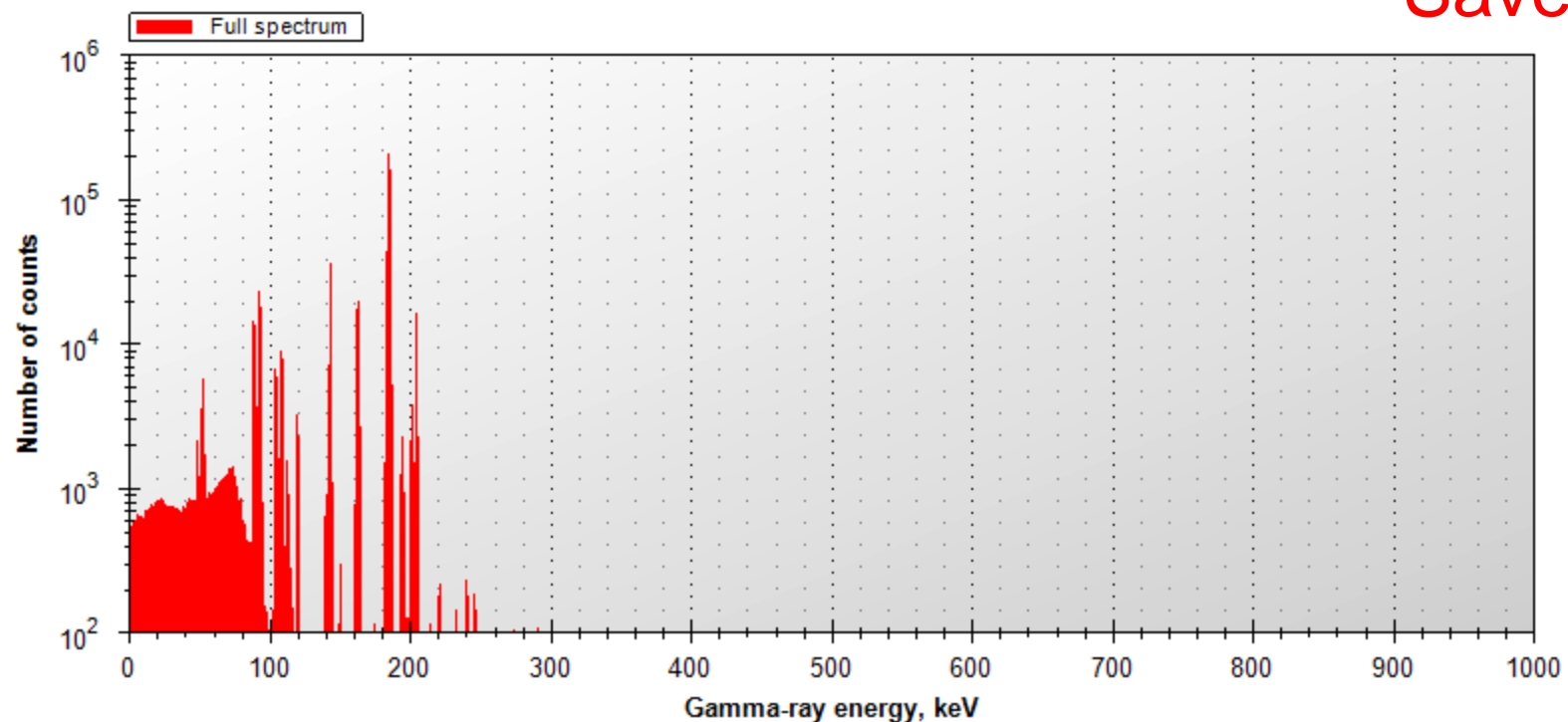
Tools



Data displayed: Statistical number of counts

View/Save results in Text format or a IAEA-SPE spectrum.

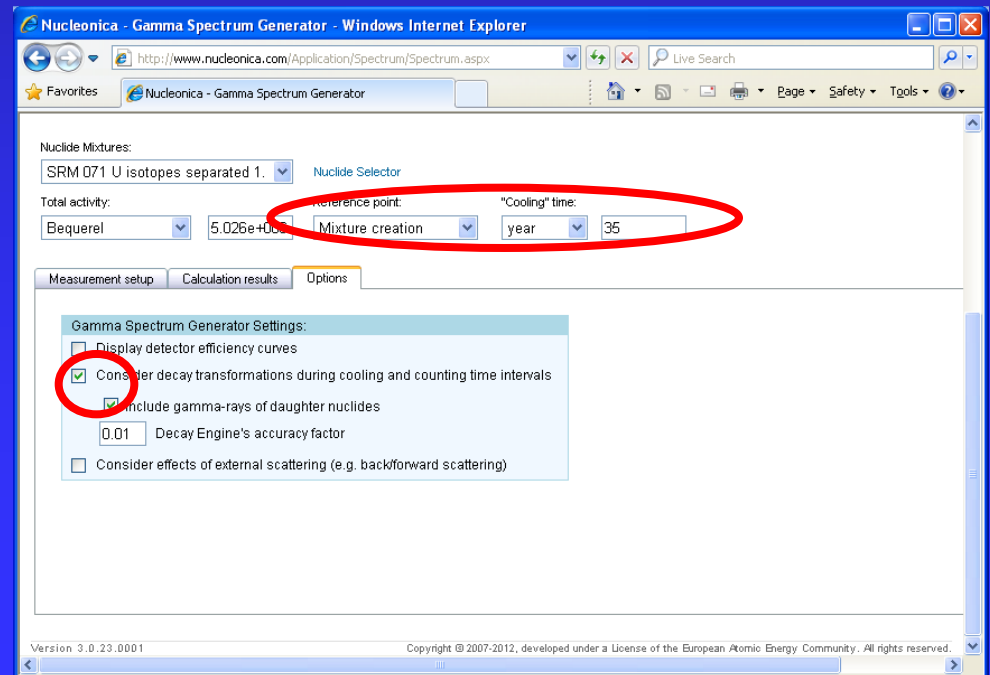
Gamma-Spectrum Simulated for HPGe (rel. eff. 140.9%)

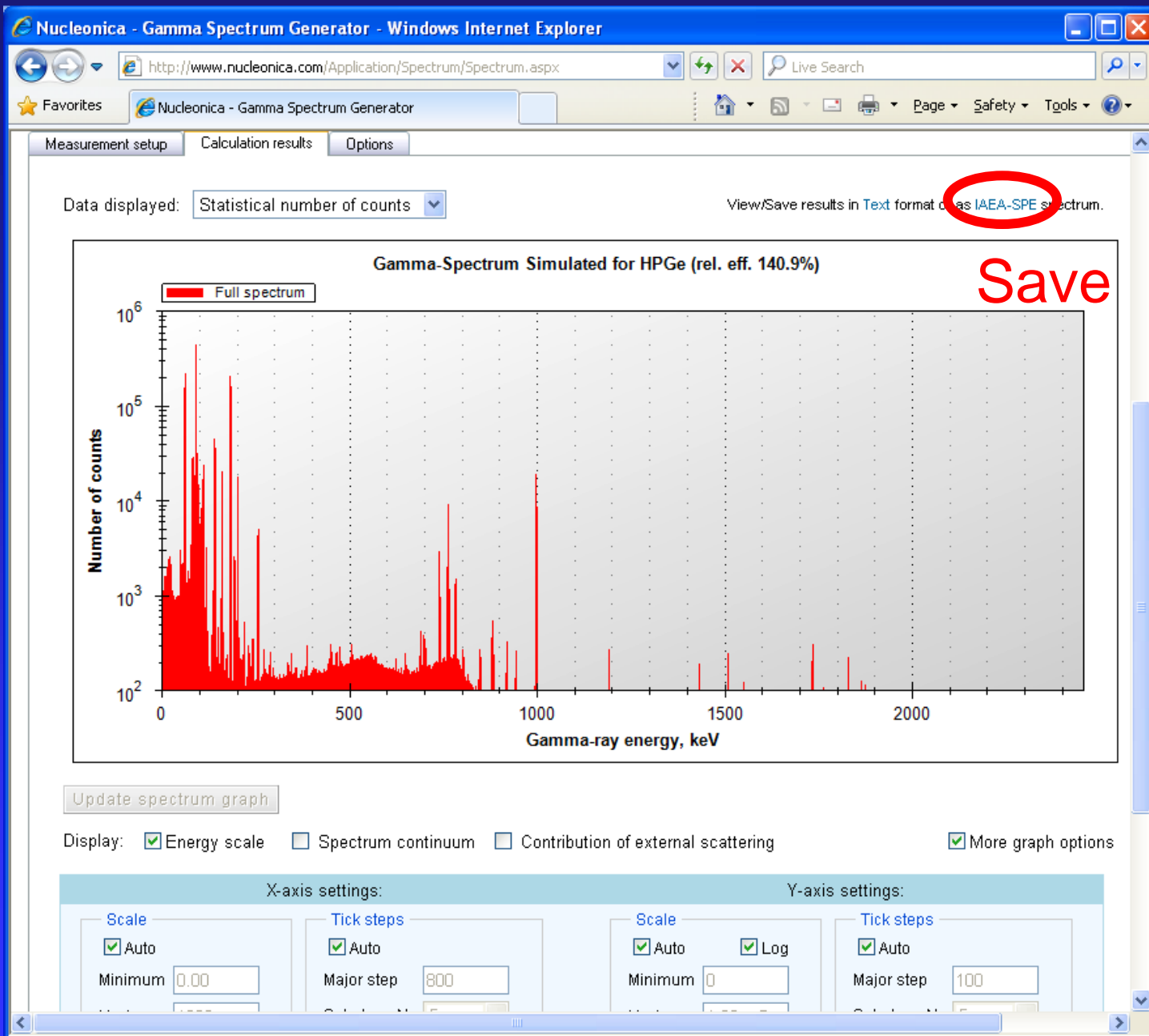


Update spectrum graph

35 years later

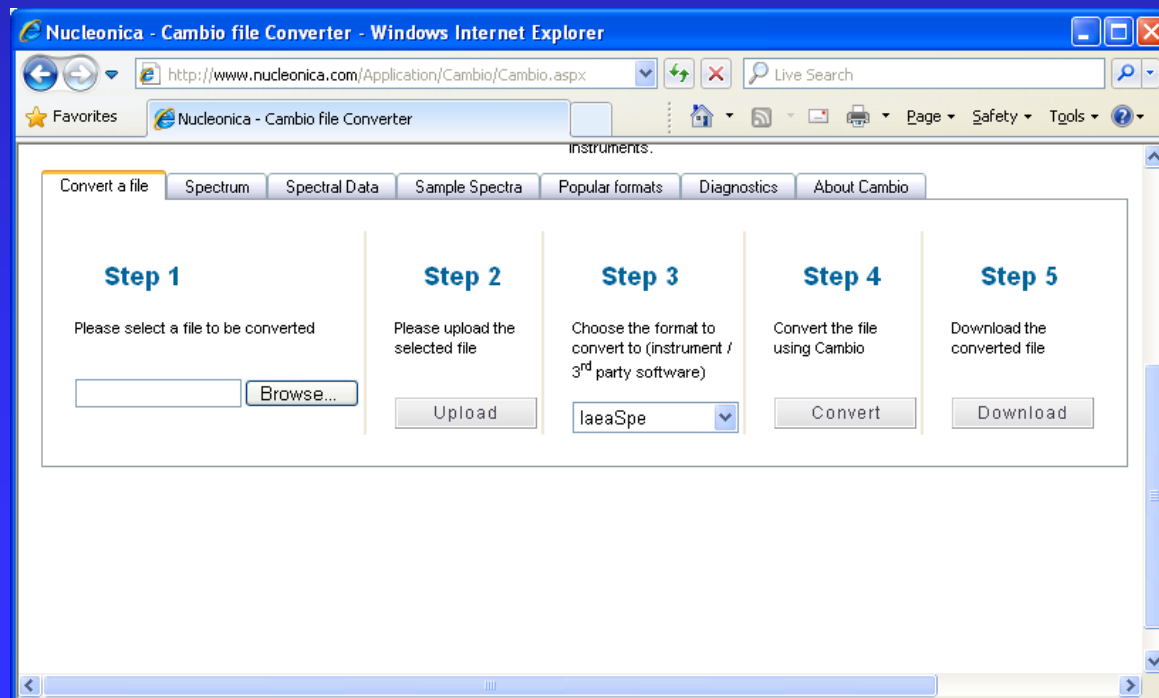
- Options tab
- Consider decay transformations
- Mixture creation
- Cooling time 35 years
- Measurement setup
- Start





Compare with Cambio File Converter

- Compare the spectra with Cambio
- Upload both
- Go to the Spectrum Tab



Convert a file

Spectrum

Spectral Data

Sample Spectra

Popular formats

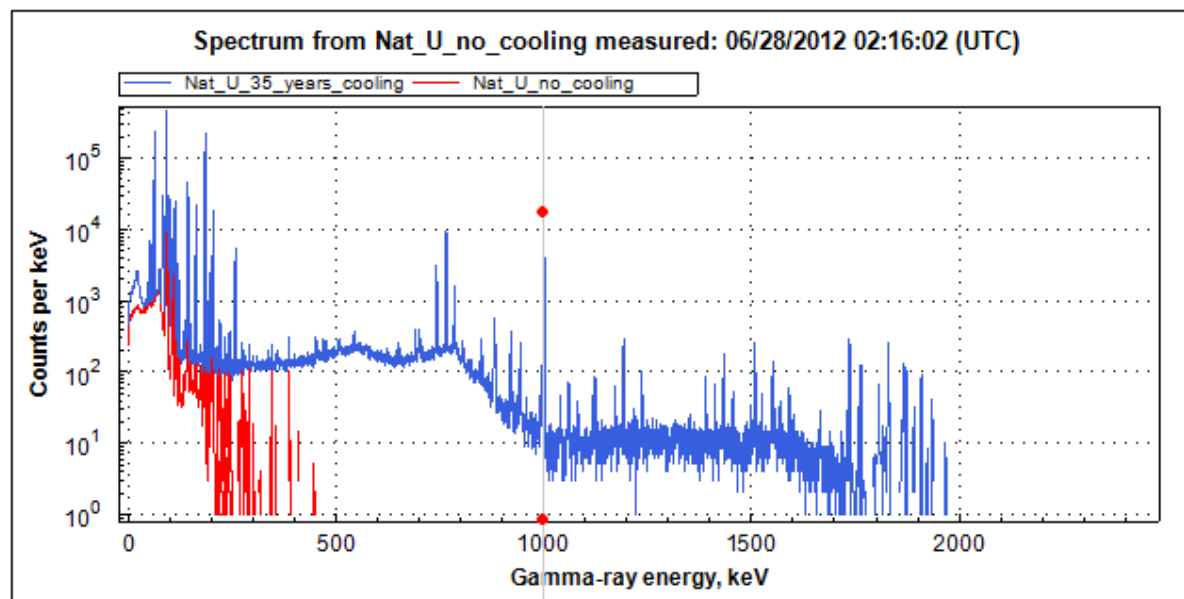
Diagnostics

About Cambio

☒ Nat_U_no_cooling.spe☒ Nat_U_35_years_cooling.spe

Update

Delete All



Spectral data at cursor position

Energy, keV	Channel	Counts/keV
1000.650	3335	1.78340e+4
996.450	3321	0.00000e+0

Show Graph Settings

Gamma Lines near cursor (from standard.lib, 580 lines)

Nuclide	Decay	Half-life	Energy, keV	Emission Probability (%)
Ac228	β^-	6.13 h	968.97	1.742E01
Pa234	β^-	1.17 m	1000.99	6.518E-01

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Thank you